THE BIOLOGY AND MORPHOLOGY OF THE IMMATURE STAGES OF *MACROCERA ANGLICA* EDWARDS.

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The early stages of this fly are unknown and they are here described for the first time. The remarkable shape of the larva, resembling more a small earth-worm than the larva of a fly, makes it an interesting object of study.

The records of the British Museum show that the fly was found in the New Forest, Stocken Church, Crowborough and Welwyn. Moreover, I have seen specimens of this fly from Egypt in the British Museum. They were darker than the English type.

I found the larvæ of Macrocera under the loose bark of damp moist logs of oak, ash and elm in Richmond park and Epping forest near London. The bark was stripped gently, and the larvæ were found living separately each under its own web of saliva. The web is hygroscopic and on it are suspended droplets of clear fluid. The web consists of fine threads about three to four inches long. In constructing this web, the larva anchors one end of its slimy salivary thread to the bark; the head is then raised, and the thread is worked forwards and backwards. Inside the web, a stouter thread runs from one end to the other.

The movements of the larva are very characteristic. It glides with greatest ease and even with rapidity over the even surface of fungoid growth covering the bark. In doing so, it is assisted by the fine threads which it emits so as to bridge over these inequalities. It moves forwards and

backwards with equal facility. Sometimes it turns by reversing its head and gliding along its side.

When the larva is full-grown, it advances to one extremity of the web and forms outside it a curious little mass of silken matter, so irregularly formed that it is scarcely entitled to be called a cocoon. The body is then shortened and the thoracic region is markedly thickened. The skin of the larva splits along the mid-dorsal line and the pupa draws itself forward leaving the old larval skin behind. If undisturbed, the imago often remains quiescent for 3 to 4 days, but will rush out with amazing celerity at the slightest disturbance.

Luminosity

In a closely related species, *Ceroplatus sesioides*, Whalberg (1848) was the first to state that the larva and pupa of Ceroplatus were luminous. Norris (1894) gave an account of the luminosity of the New Zealand "glow worm." He further suggested that the light emitted from the larva helped to attract small insects which the larva readily devoured.

Wheeler and Williams (1916) described the luminous organs in the New Zealand "glow worm," *Bolitophila luminosa*[1] as consisting of "the dilated tips of the four malpighian tubules which appear as four curved luminous rods and therefore constitute the photogenic organ." Hudson (1926) stated that the light emitted was brighter on warm damp nights and brightest immediately before daybreak.

In Macrocera and Ceroplatus which I reared in my bedroom, I carefully looked for luminosity in the larval and pupal stages of these insects, for several nights, and in no case was it seen. It is probable that the luminosity in the European *Ceroplatus sesioides* recorded by Wahlberg was due to phosphorescent bacteria as is the case in certain chironomus larvæ.

[1]Dr. F. W. Edwards kindly sent me some larvae of the New Zealand "glow worm." From the morphology of the larva, it is clear to me that the larva is related to the European Ceroplatus and not Bolitophila. Hudson later introduced the name *Arachnocampa luminosa* for the New Zealand "glow worm."

Food of Macrocera

Most Mycetophilid larvæ feed on fungus spores, hence their old name Fungivoridæ. Some species are said to be carnivorous.

Norris, Wheeler and Williams attribute a carnivorous habit to the New Zealand "glow worm."

Hudson bred the larva in small tanks by feeding them with small flies which he regularly introduced. Thus, he said, "There was in fact practically nothing else in the tank which could have sustained the larva during the three and half months they have been in captivity and accounted for the speedy disappearance of the numerous flies so frequently introduced."

Cheetham recorded a carnivorous habit for *Polylepta leptogaster* and Hungerford stated that *Sciara coprophila* fed on the dead bodies of the adults of their kind.

Mansbridge and Buston showed that the droplets of fluid in the webs of Platyura and Ceroplatus contain oxalic acid of sufficient strength to kill insects coming in contact with it. The excretion of oxalic acid by such larvæ is unexpected as it is by no means a product of larval metabolism. Such excretion is an aid to their carnivorous habit.

I have examined by transparency several young Platyura, Macrocera and Ceroplatus and found their gut containing fungus spores. In two instances, I found the remains of some Collembola in the web of Macrocera, but such remains form a nice nidus for fungal growth. It is probable that these larvæ may be partly carnivorous and partly fungivorous.

The larvæ of *Polylepta leptogaster* and *Sciara coprophila* are undoubtedly fungus eaters. It is evident that the carnivorous habit in Mycetophilidæ should be restricted to the web spinning species, namely the Ceroplatinæ, Macrocerinæ and Platyurinæ.

Morphology

The mature larva (Fig. 1, Pl. 4) is 20 mm. long and 1.5 mm. broad. The dorsal surface is convex and the ventral is flat. The larva is more like a small annelid worm or as Dufour said of the larva of Ceroplatus, "Elle est larve de dip-

tère par sa partie antérieure et annelide par la reste du corps." The larva is yellowish in colour especially towards the posterior half. The anterior four and last body segments are moderately pigmented.

The integument is thin, polished and shining. The body of the larva is free from hairs except for six groups of sensory hairs situated in the three thoracic segments in direct relationship of the imaginal buds of the legs. Each group consists of four hairs of equal length.

The body of the larva is composed of 12 body segments; the first four of which are smaller and quite distinct from the rest. They are rectangular in shape and the sides are produced into small sacs. The skin of the other body segments is thrown into numerous transverse folds. Each fold is produced into a small sac at the sides. In preserved material, the last 8 body segments are difficult to make out on account of the transverse folds; thus in the closely related genus Ceroplatus, Réaumur thought the body segments were innumerable, while Husdon counted 19 body segments in the New Zealand "glow worn." The last body segment (fig. 8) is provided with two conical papillæ which are of variable size according to their state of turgescence.

The head (Figs. 2, 3) is quadrate, dark brown and partly retractile in the first body segment. The frontal plate is egg-shaped with the pointed end situated on the posterior margin. The latter shows two deep lateral emarginations. The lateral epicranial plates curve towards the ventral surface of the head and meet anteriorly leaving a bell-shaped area covered with transparent chitin (Fig. 3). Anteriorly, each plate sends two tongue-shaped pieces of chitin which articulate with the condyles of the mandible.

The antenna (an. Fig. 2) is convex and resembles a watch glass. It is supported by a strongly chitinised base and an annular band of chitin outside which four minute papillæ are present.

The eyes (E. Fig. 3) are small vestigial structures situated postero-lateral to the antennæ. Each consists of a transparent membrane overlying a layer of pigmented cells.

The labrum (Fig. 4) is supported by a well developed chitinised frame which adjoins the frontal plate. The lat-

eral ends of the frame articulate with two well developed arms (c.r.) which pass ventral to the labrum. Each arm is provided with a fan-shaped organ, composed of several curved teeth, whose forward and backward movements help to direct the food particles towards the mouth opening. The labrum is a fleshy hood-like protuberance extending forward and downwards to recurve within the mouth. It is provided with 8 pairs of dorsal papillæ.

The mandible (Fig. 5) is elongated and consists of a convex dorsal and a large flat ventral lamella. The dorsal lamella is provided with one tooth and a well developed prostheca at the inner basal angle. On the medial border, the mandible carries three teeth and a small rounded tubercle.

The muscles operating the mandible are well developed and consist of an abductor and an adductor muscle. The abductor muscle (ab. m. Fig. 5) takes it origin from the posterior and lateral side of the epicranial plate and consists of five bundles which converge towards the upper slender tendon which is inserted to the upper angle of the mandible. The adductor muscle (ad.m) arises partly from the lateral and partly from the ventral surface of the epicranial plate. The ventral and dorsal bundles converge towards the adductor tendon to be inserted at the inner basal angle of the mandible ventral to the prostheca.

The maxillæ lie ventral and parallel to the mandibles. Each maxilla (fig. 6) consists of two lobes. The inner lobe or maxilla proper is cultriform and carries seven teeth, the last of which is strongly chitinised and more rounded than the rest. The outer lobe is provided with an oval area anteriorly, which is covered with a transparent membrane and bears one large circular and five small sensory papillæ. The maxilla is produced posteriorly as a strongly chitinised rod which serves for the attachment of the adductor muscle. The two maxillæ are supported along their posterior border by two triangular plates—the maxillary plates (mx. pl. Fig. 3) —which meet along the mid-ventral line.

The maxilla is provided with an adductor and an abductor muscle. The first consists of several bundles which arise from the apex and lateral margin of the occipital foramen and are inserted to the rod-shaped process of the maxilla.

The adductor muscle takes its origin from the lateral side of the epicranial plate. It consists of several bundles which converge to a long slender tendon which is inserted to the outer basal angle of the maxilla.

The hypopharynx (Fig. 7) lies dorsal to the maxillæ. It consists of two horizontal and two vertical processes. The free ends of the latter are seen between the inner borders of the maxillæ (hy, Fig. 3). Following them anteriorly, they pass dorsal to the maxillæ, slightly diverging one from the other and end by articulating with the horizontal processes. The horizontal processes resemble chamois horns. They meet anteriorly at the mid-ventral line and support a semicircular membrane whose free border carries several sensory papillæ (sp. Fig. 7).

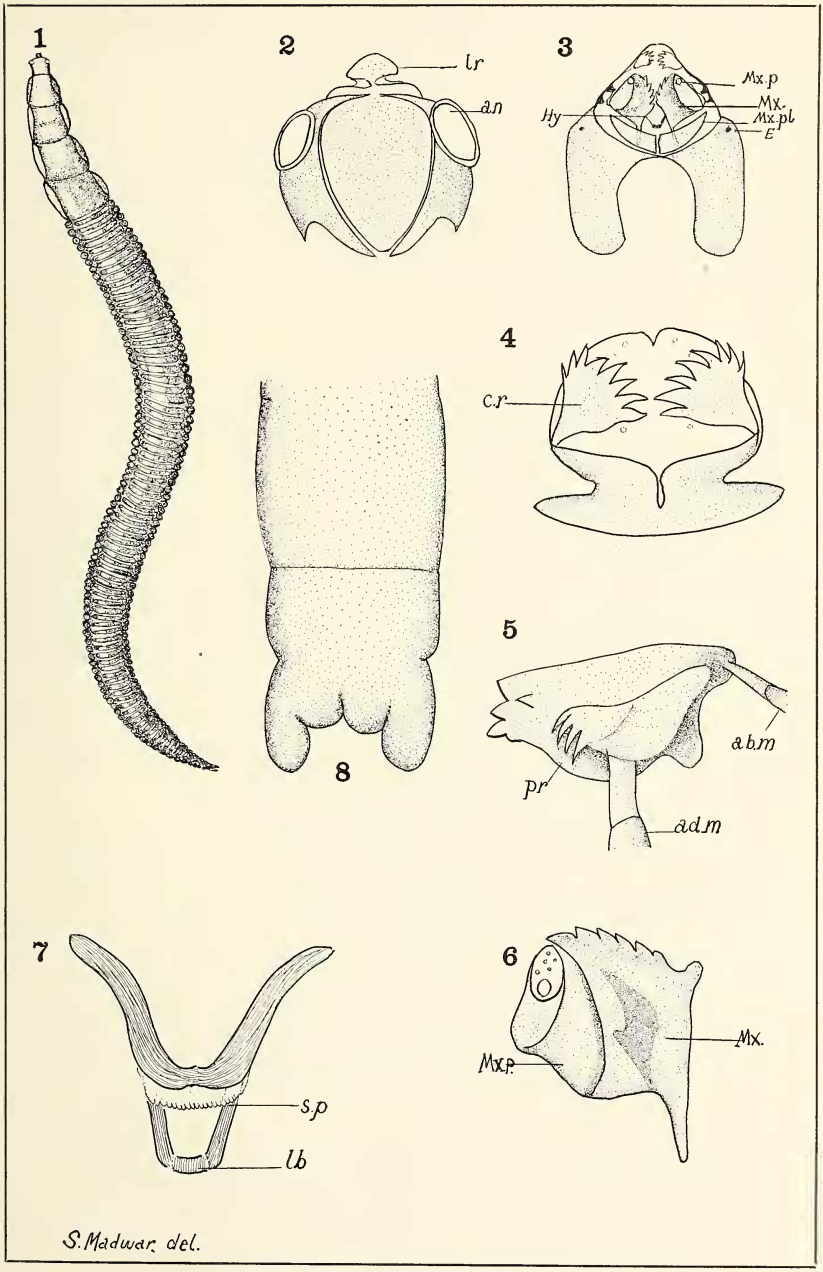
The labium (lb. Fig. 7) is reduced to a small rectangular plate situated between the free ends of the vertical processes. The opening of the salivary duct lies dorsal to the labium.

The alimentary canal consists of a short pharynx followed by a narrow tubular œsophagus which is invaginated in the proventricules. The mid-gut is in the form of a straight tube which gradually narrows down as it joins the hind-gut. The junction of the mid with the hind-gut is marked by four malpighian tubules which arise separately and extend forward, then backwards surrounding the hind-gut. From the anterior end of the mid-gut, two gastric cæca arise separately and extend backward to the 6th body segment. In the living larva, the cæca exhibit strong peristaltic movements. The two salivary glands are in the form of two long narrow convoluted tubes which extend to the 8th body segment. Anteriorly, they unite to form a common duct which opens between the distal ends of the vertical processes of the hypopharynx.

Respiratory System

The larvæ of Macrocera, Ceroplatus and Platyura are apneustic. The tracheal system is well developed in Macrocera, consisting of two latero-dorsal longitudinal trunks which extend from the first to the last body segment. The two trunks are connected together by 8 transverse branches situated at the end of the metathorax and the first seven

Psyche, 1935 Vol. 42, Plate IV.



Madwar — *Macrocera anglica.*

abdominal segments. From each trunk, eight short lateral branches take their origin, which are connected to the skin of the prothorax and first seven abdominal segments by means of lateral cords which correspond to the position of the spiracles in other Mycetophilid larvæ.

Although functioning spiracles are absent in this larva, the conditions for cutaneous respiration are extremely favorable[1]. The skin is thrown into numerous folds which increase the respiratory surface. The integument is thin and richly supplied with a subcuticular net of tracheoles. The larva lives under a hygroscopic web of salivary secretion.

Description of Plate 4

Macrocera anglica Edwards.

Fig. 1	Whole larva taken out of web	X 10
Fig. 2	Head — Dorsal aspect	X 72
Fig. 3	Head — ventral aspect	X 72
Fig. 4	Labrum — oral aspect	X 250
Fig. 5	Mandible	X 250
Fig. 6	Maxilla	X 250
Fig. 7	Hypopharynx and Labium	X 250
Fig. 8	Terminal body segment	X 72

Key to Lettering of Plate

An.	Antenna
Ab.m.	Abductor muscle
Ad.m.	Adductor muscle
C.R.	Chitinous ring
E.	Eye
Hy.	Hypopharynx
Lb.	Labium
Mx.	Maxilla
Mx.P.	Maxillary Palp
Mx.Pl.	Maxillary Plate
Pr.	Prostheca
S.P.	Sensory Papilla

[1]The modification of the respiratory system in some Dipterous larvae will be dealt with separately in a special paper.

Summary

1. The Biology and Morphology of *Macrocera anglica* is given.
2. Luminosity, development of carnivorous habits and the excretion of oxalic acid by the larva are discussed.
3. The change from the peripneustic to the apneustic condition in the larva of Macrocera is accounted for.

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